

Q-thruster Breadboard Campaign Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)



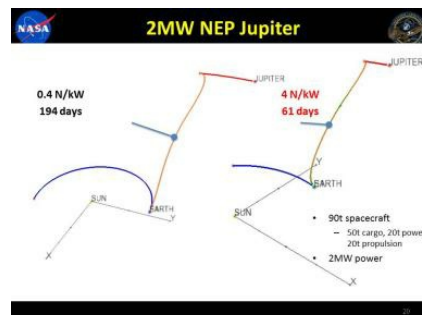
ABSTRACT

JSC's Dr. Harold "Sonny" White has developed the physics theory basis for utilizing the quantum vacuum to produce thrust. The engineering implementation of the theory is known as Q-thruster. During FY13, three test campaigns were conducted that conclusively demonstrated tangible evidence of Q-thruster physics with measurable thrust bringing the Technology Readiness Level (TRL) from TRL 2 to early TRL 3. This project will continue with the development of the technology to a breadboard level by leveraging the most recent NASA/industry test hardware. This project will replace the manual tuning process used in the 2013 test campaign with an automated Radio Frequency (RF) Phase Lock Loop system (precursor to flight-like implementation), and will redesign the signal ports to minimize RF leakage (improves efficiency). This project will build on the 2013 test campaign using the above improvements on the test implementation to get ready for subsequent Independent Verification and Validation (IV&V) testing at Glenn Research Center (GRC) and Jet Propulsion Laboratory (JPL) in FY 2015. Q-thruster technology has a much higher thrust to power than current forms of electric propulsion (~7x Hall thrusters), and can significantly reduce the total power required for either Solar Electric Propulsion (SEP) or Nuclear Electric Propulsion (NEP). Also, due to the high thrust and high specific impulse, Q-thruster technology will greatly relax the specific mass requirements for in-space nuclear reactor systems. Q-thrusters can reduce transit times for a power-constrained architecture.

ANTICIPATED BENEFITS

To NASA funded missions:

Due to the increased thrust to power, the Q-thruster can enable power constrained Solar Electric Propulsion (SEP) missions to close without needing chemical kick stages as might be used in a SEP-chemical hybrid mission. Further, Q-thrusters can reduce the Initial Mass in Low Earth Orbit (IMLEO) necessary for a

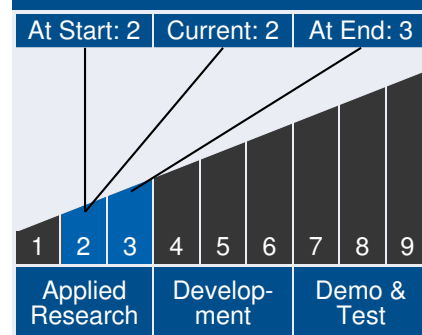


Q-thruster Jupiter Exploration Mission Analysis for 90 MT S/C, 2MW power

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Technology Maturity



Management Team

Program Executive:

- John Falker

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mission or span of missions associated with an architecture.

To NASA unfunded & planned missions:

Q-thruster technology has a much higher thrust to power than current forms of electric propulsion (~7x Hall thrusters), and can significantly reduce the total power required for either Solar Electric Propulsion or Nuclear Electric Propulsion. Also, due to the high thrust and high specific impulse, Q-thruster technology will greatly relax the specific mass constraints for in-space nuclear reactor systems. Q-thrusters can reduce transit times for a power-constrained architecture.

To other government agencies:

Q-thrusters can enable Department of Defense (DoD) missions that require multiple orbital plane changes and hence large delta-v budgets.

To the commercial space industry:

Q-thrusters can enable the communications satellite industry to have assets with longer lifetimes, and potentially reduce the thermal load on the satellite due to reduced power requirements for a target thrust necessary for orbit maintenance. This would translate into reduced overall cost for the development of the asset.

To the nation:

Q-thrusters have the potential to enable human missions to Mars even with the current anticipated tight power budgets. As power levels increase, transit times can be reduced.

With a persistent power source such as an in-space nuclear reactor, q-thrusters can enable bold human exploration missions to Mars, the outer solar system, and beyond.

DETAILED DESCRIPTION

Q-thruster technology is a mission enabling form of electric propulsion and is already being traded by NASA's Concept Architecture Team (CAT) & Human Space Flight (HSF)

Management Team (cont.)

Program Manager:

- Ronald G Clayton

Project Manager:

- Andre Sylvester

Principal Investigator:

- Harold White

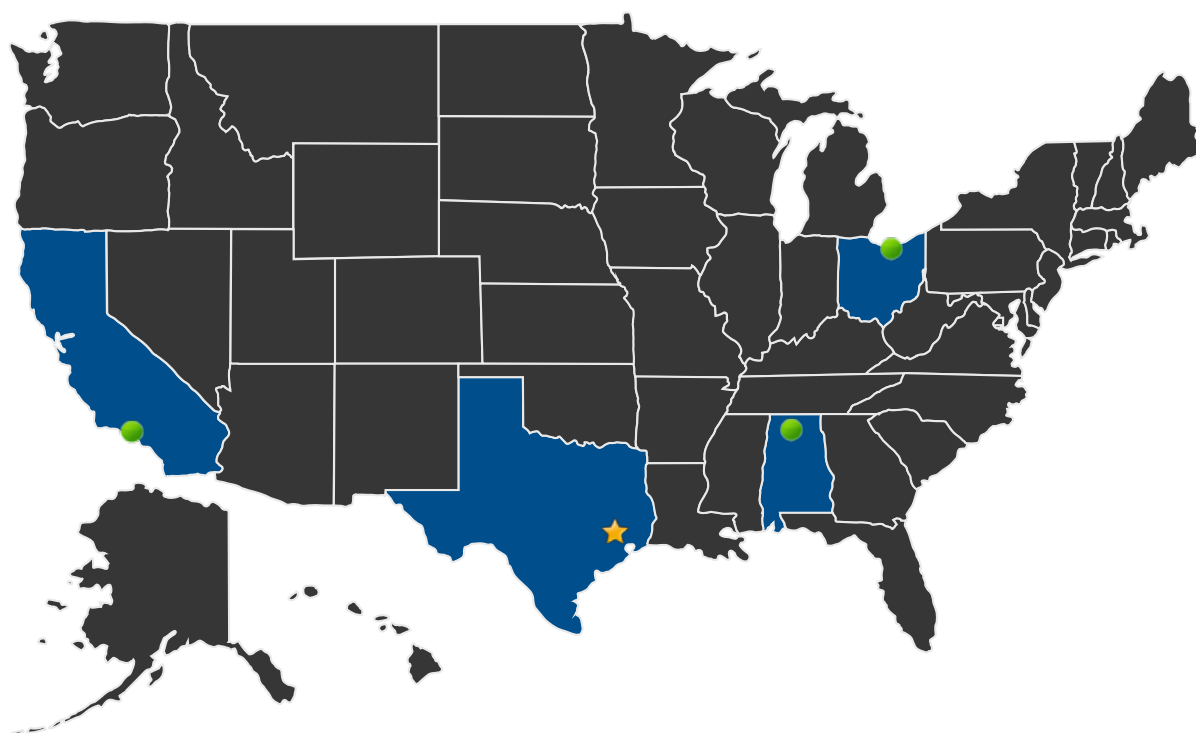
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Architecture Team (HAT) as an electric propulsion effector for Asteroid Recovery Vehicle (ARV) mission extensibility options out to Mars. The Nuclear Electric Propulsion mission allows for rapid transit while allowing for a heavy, more near-term reactor design and the Solar Electric Propulsion mission allows for a power starved approach with similar mission durations to Design Reference Architecture - DRA 5.0 that would not be possible without the Q-thruster technology.

U.S. LOCATIONS WORKING ON THIS PROJECT



■ U.S. States With Work ★ **Lead Center:**
Johnson Space Center

- **Supporting Centers:**
- Glenn Research Center
 - Jet Propulsion Laboratory
 - Marshall Space Flight Center

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Other Organizations Performing Work:

- Boeing
- Cannae
- Lockheed Martin

Contributing Partners:

- Defense Advanced Research Projects Agency (DARPA)

DETAILS FOR TECHNOLOGY 1

Technology Title

Q-thruster Breadboard Campaign

Technology Description

This technology is categorized as a hardware subsystem for ground scientific research or analysis

A Q-thruster is a form of electric propulsion. Through the use of electric and magnetic fields, a Q-thruster pushes virtual particles (electrons/positrons) in one direction, while the Q-thruster recoils to conserve momentum. As a classical analogy, this principle is similar to how a submarine uses its propeller to push water in one direction, while the submarine recoils to conserve momentum.

Capabilities Provided

Q-thruster technology has a much higher thrust to power than current forms of electric propulsion (~7x Hall thrusters), and can significantly reduce the total power required for either Solar Electric Propulsion or Nuclear Electric Propulsion. Also, due to the high thrust and high specific impulse, Q-thruster technology will greatly relax the specific mass constraints for in-space nuclear reactor systems. Q-thrusters can reduce transit times for a power-constrained architecture.

Potential Applications

Q-thrusters can be used as an in-space primary propulsion system for a spacecraft for both science missions and human space exploration missions. Using solar electric propulsion, it can be effectively used for human missions out to Mars that have power constraints that limit overall power budget to the few hundreds of kW (e.g. 300kW). Coupled with small nuclear power sources, it may be effective at reducing transit times for science missions to the outer solar system and beyond.

Active Project (2013 - 2014)

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Performance Metrics

Metric	Unit	Quantity
Thrust to Power (at maturity)	N/kW	0.4